

## **Response of Introduced Sunflower Hybrids to Broomrape (*Orobanche cumana* W.)**

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### **Abstract**

ALEXANDROV, V. and S. DIMITROV, 2007. Response of introduced sunflower hybrids to broomrape (*Orobanche cumana* W.). *Bulg. J. Agric. Sci.*, 13: 521-527

The response of 16 introduced sunflower hybrids, bred by Pioneer, Monsanto and Naucni institut za ratarstvo i povrtarstvo-Novı Sad, to broomrape in the conditions of natural infection background, and was studied. The tests took place on leached chernozem-smolnitsa in the Complex Experimental Station in the town of Yambol in the period 2001-2003. Cv. Peredovik and hybrid Albena were used as controls.

None of the tested sunflower hybrids proved immune to *Orobanche cumana* W. One hybrid showed resistance to the parasite and nine – medium resistance and all had higher yield vs. controls. They would be recommended to grow in the conditions of strong broomrape infection. Controls were parasite sensitive.

*Key words:* response, sunflower, introduced hybrids, broomrape (*Orobanche cumana* W.)

### **Introduction**

Broomrape develops on the roots of sunflower plants and feeds on their nutritive compounds and water thus seriously damaging the yield. Peresykin (1987) reported losses within 30-70%. According to Piven et al. (2004), low broomrape infestation could result in losses of 5% to 20%, boosted to over 50% in cases of strong infestation. In the Mediterranean, the parasite is harmful to the yield of sen-

sitive sunflower hybrids (Labrousse et al., 2004). The parasite is preserved in soil with the seeds that are difficult to eradicate. The introduction of tolerant hybrids is an efficient method of *Orobanche cumana* W. control. Presently, a number of foreign companies sell on the Bulgarian market sunflower hybrids without adequate information on their resistance to this parasite.

Our objective is to examine the response of some introduced sunflower hybrids to broomrape.

## Material and Methods

The study was carried out on leached chernozem-smolnitsa on the experimental field of the Complex Experimental Station in Yambol in 2001-2003. The response of 16 introduced sunflower hybrids, selected by Pioneer, Monsanto and Naucni institut za ratarstvo i povrtarstvo-Novı Sad, to *Orobanche cumana* W. was tested in natural infection background. Control varieties involved cv. Peredovik and the hybrid Albena, common to our country. The separate samples were planted in four replications with 5000 plants/decare each on 15 m<sup>2</sup> plots.

At the end of the flowering phase, the number of healthy and infected specimens was counted in a random sample of 100 plants and the percentage of infected plants was determined. The average number of broomrape flower-bearing stems per infected plant was reported. The Executive Agency for Variety Testing, Field Inspection and Seed Control (IASAS) scale was used in order to establish the response of the studied hybrids to the local *Orobanche cumana* W. populations:

- resistant - below 5%
- medium-resistant - 5-20%
- sensitive - 20-50%
- very sensitive - over 50%

The average yield and plant height of the separate hybrids were recorded as well.

## Results and Discussion

Meteorological conditions during sunflower vegetation were diverse in the separate years of the study, yet typical of the area (Table 1). Average monthly temperature in 2001 gradually increased during vegetation and was considerably higher during flowering and ripening phases. Rainfalls marked a peak in button formation - beginning of flowering phase, going down to 2 l/m<sup>2</sup> at the end of vegetation. This combination of climatic factors created conditions for ruining the normal physiological development of the plants in the stages of flowering and ripening thus enabling the harmful effect of broomrape.

The average monthly temperatures in 2002 and 2003 were close and increasing in a similar way, while in 2002 the increase

**Table 1**  
**Meteorological conditions in the period 2001-2003**

Year	month										Rainfal's sum, l/m <sup>2</sup>
	April		May		June		July		August		
	T	Q	T	Q	T	Q	T	Q	T	Q	
2001.00	11.70	53.70	18.90	30.70	20.80	68.50	25.60	56.0	25.40	2.0	210.90
2002.00	10.40	27.80	16.80	29.60	21.90	13.20	25.30	73.80	22.90	40.40	184.80
2003.00	9.40	41.10	18.70	23.50	22.90	3.0	24.0	49.50	25.30	20.20	137.30
Average 30 year	11.20	50.60	16.10	57.10	20.50	66.20	23.70	40.10	22.70	36.10	250.10

Legend: T-average temperature for month-°C

Q-sum on rainfall for month-l/m<sup>2</sup>

**Table 2**  
**Relation of introduced sunflower hybrids to broomrape**

Firm, hybrids	Attack plants, %			
	2001	2002	2003	average
Pioner				
PR64A54	21.1	30.5	2.1	17.9
PR64A70	22.7	16.2	2.4	13.8
XF 4946	20.5	7.8	2.2	10.2
Beril	42.1	20.8	5.1	22.7
PR64A83	17.8	3.9	2.2	7.9
PR63A90	30.3	13.6	4.1	16.0
Monsanto				
Tequila	25.0	3.3	1.2	9.8
Dekalb	26.5	1.7	1.3	9.8
MX 0123	12.0	1.2	1.1	4.8
AC 508	11.6	25.7	2.4	13.2
MX 0322	22.1	2.5	1.2	8.6
Novi Sad				
NS 01	92.0	41.9	3.9	45.9
NS 702	91.7	22.8	6.7	40.4
NS 111	100	35.2	10.4	48.5
NS 492	98.8	56.9	2.8	52.8
Control				
Albena	92.9	48.3	20.5	53.9
Peredovik	91.1	35.6	4.9	43.9
average	42.3	18.9	3.3	

during the ripening phase was lower. Rainfall records showed decrease in button formation stage, peak during flowering-beginning of ripening and, again, decrease during full ripeness. Meteorological conditions during both years were comparatively favorable for the normal development of the plants and reduced the effect of the parasite.

The studies showed that hybrid NS 492

was very sensitive to broomrape according to the IASAS scale – 52.8% (Table 2). According to this scale, the following hybrids were sensitive to the parasite: Beril – with 22.7% of infested plants, NS 702 – 40.4%, NS 01 – 45.9% and NS 111 – 48.5%. All the remaining samples were medium resistant to broomrape. Only MX 0123 with 4.8% of infested plants could be characterized as broomrape resistant.

**Table 3**  
**Average number of broomrape flower-bearing stems per infected plants**

Firm, hybrids	Average number of broomrape stems/infected plants			
	2001	2002	2003	average
Pioner				
PR64A54	3.2	1.6	0.5	1.8
PR64A70	1.4	1.0	0.5	1.0
XF 4946	1.5	1.1	0.5	1.0
Beril	2.1	1.4	1.1	1.5
PR64A83	1.4	1.1	0.5	1.0
PR63A90	3.6	1.4	1.3	2.1
Monsanto				
Tequila	2.0	1.0	0.5	1.2
Dekalb	4.8	2.0	0.5	2.4
MX 0123	1.6	1.0	0.5	1.0
AC 508	3.4	1.6	1.2	2.1
MX 0322	1.5	1.3	1.0	1.3
Novi Sad				
NS 01	5.7	1.8	1.4	2.9
NS 702	10.0	1.4	1.3	4.2
NS 111	6.3	1.5	1.2	3.0
NS 492	8.3	1.4	0.5	3.4
Control				
Albena	7.7	2.2	1.5	3.8
Peredovik	6.2	2.0	0.5	2.9

Both controls – the hybrid Albena with 53.9% and cv. Peredovik with 43.9%, proved very sensitive to sensitive.

The natural infestation background was diverse during the period of study, due to the irregular accumulation of broomrape infection in soil and that reflected on the infestation rate of the hybrids during the separate years. Thus, the percentage of infested plants varied within 11.6% and 100% in 2001 and the reason for the lower

infestation in some areas of the field was probably the lower rate of background infestation.

The bigger number of broomrape flower-bearing stems per infected plant (Table 3) was reported in very sensitive and sensitive hybrids: NS 702 – 4.2; Albena – 3.8; NS 492 – 3.4; NS 111 – 3; NS 01 – 2.9 and Peredovik – 2.9 pieces as well as in medium resistant ones: Dekalb – 2.3 pieces; PR 63A 90 and AC 508 – 2.1

**Table 4**  
Seed's yield of introduced sunflower hybrids

Hybrids	Average yield, kg/dka				% toward Albena	% toward Peredovik
	2001	2002	2003	average		
PR64A54	121.5	108.1	127.8	119.1	118.6	120.7
PR64A70	122.6	131.8	157.2	137.2	136.6	139.0
XF 4946	117.9	98.6	130.1	115.5	115.0	117.0
Beril	85.9	94.7	109.4	96.7	96.3	97.9
PR64A83	132.4	129.2	142.9	134.8	134.3	136.6
PR63A90	125.1	123.8	131.9	126.9	126.4	128.6
Tequila	107.3	141.2	156.9	135.1	134.6	136.9
Dekalb	98.1	144.6	152.3	131.7	131.2	133.4
MX 0123	138.8	139.6	143.7	140.7	140.1	142.6
AC 508	111.5	97.8	127.9	112.4	111.9	113.9
MX 0322	128.1	122.4	154.3	134.9	134.4	136.7
NS 01	64.9	70.2	73.6	69.6	69.3	70.5
NS 702	101.8	103.5	107.1	104.1	103.7	105.5
NS 111	85.1	88.9	113.4	95.8	95.4	97.1
NS 492	62.2	76.7	102.2	80.4	80.1	81.4
Albena	87.7	92.3	123.4	100.4		100.0
Peredovik	86.6	97.7	111.7	98.7	100.0	
average	104.6	109.5	127.3	113.8		

pieces each. This index was below 1.8 in the remaining medium resistant hybrids and only 1 piece in the resistant.

Sunflower broomrape infection affected yield as well (Table 4). The comparison of average yields of tested specimens showed that almost all exceeded the controls, i.e. hybrid Albena and cv. Peredovik. However, the hybrids of the sensitive group made an exception with lower yield vs. hybrid Albena, as follows: NS 01-30.7%; NS 492-19.9%; NS 111-4.6% and Beril-3.7% lower. The highest yield increase was reported for the resistant hybrid MX 0123 – with 40.1%. A con-

siderable yield increase was also obtained in hybrids PR63A90-26.4%; Dekalb-31.2%; PR64A83-34.3%; MX 0322-34.4%; Tequila-34.6% and PR 64A 70-36.6%, which was obviously due to the broomrape tolerance of those hybrids.

*Orobanche cumana* W. infection of sunflower plants was detrimental to physiological processes and caused delayed growth and development. It also reflected on the botanical index of plant height. Thus, while the normal height of the control cv. Peredovik was 200 cm, the average height measured throughout the three years of testing was 177 cm (within 172.2

**Table 5**  
**High of plant's stem on introduced sunflower hybrids**

Hybrids	High of plant's stem, cm				±sx
	2001	2002	2003	x	
PR64A54	147.8	164.3	158.5	156.9	2.42
PR64A70	152.8	167.8	177.1	165.9	3.54
XF 4946	135.9	159.5	150.7	148.7	3.44
Beril	153.9	164.9	160.9	159.9	1.61
PR64A83	143.9	165.9	153.2	154.3	3.19
PR63A90	151.1	172.6	164.9	162.9	3.14
Tekuila	148.3	163.6	172.2	161.4	3.49
Dekalb	163.9	167.1	174.1	168.4	1.51
MX 0123	166.6	168.8	168.1	167.8	0.32
AC 508	145.7	150.4	159.7	151.9	2.06
MX 0322	165.2	175.5	171.6	170.8	1,50
NS 01	149.6	152.3	159.8	153.9	1.52
NS 702	149.8	149.3	151.1	150.1	0.27
NS 111	144.2	153.2	166.9	154.8	3.29
NS 492	149.6	159.7	164.8	158.0	2.23
Albena	137.6	145.8	161.2	148.2	3.46
Peredovik	172.2	175.4	183.5	177.0	1.68
average	151.2	162.3	163.6	159.03	

cm and 183.5 cm) (Table 5). The height of the sunflower plants of the other control – hybrid Albena, with a regular value of 160 cm, was within 137.6 cm and 161.2 cm (an average of 148 cm). The effect of broomrape on the height of tested hybrids was the strongest in 2001, the average plant height of 151.2 cm being the lowest in the three year period. The following hybrids were affected to the strongest degree: XF 4946-135.9 cm; PR 64A83-143.9 cm; NS 111-144.2 cm; AC 508-145.7 cm; PR 64A54-147.8 cm and Tequila-148.3 cm. The effect of the parasite on height was weaker during the other two years

as can be seen from the average height of the tested hybrids – 162.3 cm in 2002 and 163.6 cm in 2003. The biggest deviation in 2002 was reported for the following materials: NS 702-149.3 cm; AC 508-150.4 cm; NS 01-152.3 cm and NS 111-153.2 cm and in 2003 – in hybrids XF 4946-150.7 cm; NS 702-151.1 cm and PR64A83-153.2 cm. The significant height reduction in 2001 could be attributed to the high rate of broomrape infection and the additional negative effect of climatic conditions. Obviously, the combination of those two factors strongly affected plant height. During the rest two years, the values of those fac-

tors were more favorable, resulting in a lower effect; hence, plant height was bigger.

### Conclusions

None of the tested 16 sunflower hybrids showed immunity to *Orobanche cumana* W. The hybrid MX 0123 showed resistance to the parasite and higher yield vs. controls, as well as lower number of broomrape stems per infected plant. Nine hybrids exhibited medium resistance to the parasite. Their yield exceeded that of controls. Those materials, as well as the resistant hybrid, would be recommended to grow in the conditions of high broomrape

infection. The control cv. Peredovik and hybrid Albena proved sensitive to the parasite.

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*Received January, 13, 2007; accepted, July, 3, 2007.*